How Wet Is Wet?: The Art and Science of Watering©

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INTRODUCTION

- The profitability of your business is controlled by the person holding the hose.
- More plants are damaged by incorrect water application than any other thing you do.
- Pesticides compensate for incorrect water application.
- Slow growth, uneven growth rate, reduced quality, and poor post-harvest survival are all signs of incorrect water application.

Watering plants is a core activity in a nursery. Most staff receive training consisting of "go water the plants." Rarely does a new employee understand the intricacies of when to water, how much to apply or the frequency of application based on plant development and weather conditions. Invariably growers either "figure it out" or become frustrated and quit your company and start the process all over somewhere else. Unfortunately while the growers are "figuring it out" they produce crops that are inconsistent in quality with increased shrink.

Part of the problem with training growers to water correctly and consistently is we use very ambiguous terminology to describe the watering process. "Too wet, too dry, medium wet, medium dry, wetter, drier, spritz, flush, soak, and drench" are all terms used to inform growers what they should be doing. When the growers don't achieve the desired results, the growers are reprimanded for failing to follow instructions.

How can growers interpret correctly standard watering terms when the managers can't define the terms? When you compound the ambiguity of the watering terminology with the requirement to modify the frequency and amount of water based on crop development, it is easy to see why growers become confused. As a defensive position, most growers keep the plants on the wet side since they aren't reprimanded for wet plants, rather just the dry ones! To compensate for excess water, growers apply fungicides to correct the root rot disease! A viscous cycle ensues where keeping the soil too wet requires watering with fungicides to correct the excess watering…

The dilemma for managers is; "How do I train growers to water when I was never trained myself?" The key to training your staff is to break the process down into definable teachable activities and then train the appropriate staff intensively. The watering process is broken down into five different levels of knowledge with each subsequent level of knowledge dependent on a thorough understanding of the previous level.

All employees need to understand "Language of Watering." This step of the knowledge pyramid involves developing a common terminology so everyone in your organization can communicate the moisture status of the crop. From shipping to growing to pot filling — if the soil is a 'W2' — everyone knows what the soil moisture level is and what they need to do about this level based on production protocols.

"When and how much to water" is knowledge growers need to master. This level trains the staff on methods to apply water using different equipment to achieve the desired moisture level.

"Where to water" and "water usage" are more complex levels of knowledge that key growers and managers need to master. The highest quality products are produced by growers who understand where in the container to apply the water and how to anticipate water usage so that plants receive enough water to survive 1–3 days.

LANGUAGE OF WATERING W1-W5

The key to determining when to water is in defining what is "dry" through "wet." Since everyone learns and processes information differently, we need to provide different ways to determine when the plants reach different points in the continuum from wet to dry. There are five distinct levels of soil moisture for peat-based medium. At each level you should be able to see and feel different criteria to help understand what level the soil has reached.

Level W5. When the soil is fully saturated, the soil moisture is a level W5. Growers will water to a level W5 when fertilizing, leaching to reduce salts, and during periods of rapid drying or rapid growth. Plants do not grow well when the soil is maintained at a level W5. At this level there is not enough oxygen in the soil to promote good root growth.

Level W5 Characteristics. The color of the soil is black and shiny. The color and shiny look are due to the free water that has filled all the pore space. If you take a soil sample in your hand, water freely drips out of your hand. The soil feels like pudding or tofu in your hand. A level W5 does not last long after watering since gravity will reduce the moisture level at the surface of the soil. Although the surface may appear dry, the bottom of the pot may remain a level W5 until roots reach the bottom of the pot.

Level W4. When gravity reduces the free water from the soil matrix the soil moisture is a level W4. At a level W4, the soil becomes dark brown and is holding the maximum water against gravity. Growers will maintain a level W4 when germinating certain genera, callusing cuttings, spot watering during periods of rapid drying, or when using very high EC levels during production. Many growers erroneously believe that a level W4 is the ideal moisture level to grow plants. At a level W4 it is easy to stretch plants and promote pythium development.

Level W4 Characteristics. The soil is a dark brown and not shiny since there is no free water present in the soil. If you take a soil sample in your hand and squeeze the soil slightly, water will drip out of your hand. At a level W5 water will drip without squeezing while a level W4 requires some force to extract water. After squeezing the soil, it retains the shape with some cracking since the water "glues" the soil together.

Level W3. As more water leaves the soil due to evaporation or uptake by the plant, the soil begins to become lighter in color and weight. As the soil turns to brown, the soil has reached a good balance between available water and air in the soil. Growers use a level W3 to encourage strong root development, reduce hypocotyl and stem elongation and reduce disease development. Although growers may want to water when the plants reach a level W3, plants will flourish when the soil is allowed to dry to level W3 or W2. The key is to determine what the moisture level is throughout

the soil profile. If the surface is a level W3, the bottom of the pot (where the roots are) may be a level W4 or W5. As the soil moisture moves to a level W3 it becomes critical to evaluate the container moisture level from top to bottom before watering to prevent excess water in the container.

Level W3 Characteristics. As more water is lost from the soil, the soil continues to become lighter in color and is brown. If you take a soil sample in your hand and squeeze as hard as possible you can get one or two drops of water from the soil. If water freely drips as you squeeze then the soil is a level W4, if no water can be squeezed out the soil is a level W2. A soil level W3 is clearly between W4 and W2. After squeezing the soil the soil will crack apart but the chunks stay stuck together.

Level W2. As the soil begins to dry further, the soil will take on a light brown to tan color. At a level W2 there is still water available to support plant growth although the plant has to "search out" the water that is available in the soil. When the soil is a level W2, root and shoot growth is restricted. Depending on growth rate and environmental conditions a plant can survive for a considerable period of time at a level W2. The challenge with maintaining a level W2 is the plants can begin wilting very rapidly if the entire root ball reaches a level W2. During high evapotranspiration periods plants have a difficult time extracting sufficient water from the soil at a level W2 while at cool–humid conditions evapotranspiration is low and plants can survive at a level W2.

Level W2 Characteristics. As the available water is lost from the soil, the soil continues to become light brown to tan. If you take a soil sample in your hand and squeeze as hard as possible you can not squeeze any water out the soil. If you squeeze the soil near your ear you can hear the soil "squeak" as the water moves through the pores of the soil. After squeezing, the soil will fall apart in your hand but if you blow on the soil it stays stuck together.

Level W1. As the available water is removed from the soil, the color turns to a light tan to gray and the soil volume may shrink in the container. Once the soil reaches a level W1 the soil becomes hydrophobic and rewetting is difficult without a wetting agent. Plants become stressed when exposed to a level W1 therefore unless the crop protocol calls for severe water stress conditions (succulents and cacti) growers avoid a level W1. It is not uncommon for growers to overreact to the surface of the soil reaching a level W1 while the lower portions of the soil ball are still at a level W2 to W4.

Level W1 Characteristics. All available water is lost from the soil and the soil turns tan to white-gray. If you take a soil sample in your hand and squeeze as hard as possible you can not squeeze any water out the soil. If you squeeze the soil near your ear you can *not* hear the soil "squeak." After squeezing, the soil will fall apart in your hand but if you blow on the soil it disperses since it can not stick together.

WHEN TO WATER

For each stage of development there is an optimum moisture level that promotes growth. We can develop scientific recommendations on "how dry is wet enough." Based on a growers production protocols, specific recommendations can be developed to help growers know "how dry is dry enough to water." The right half of the production wheel (Fig. 1) shows different water levels that will optimize growth

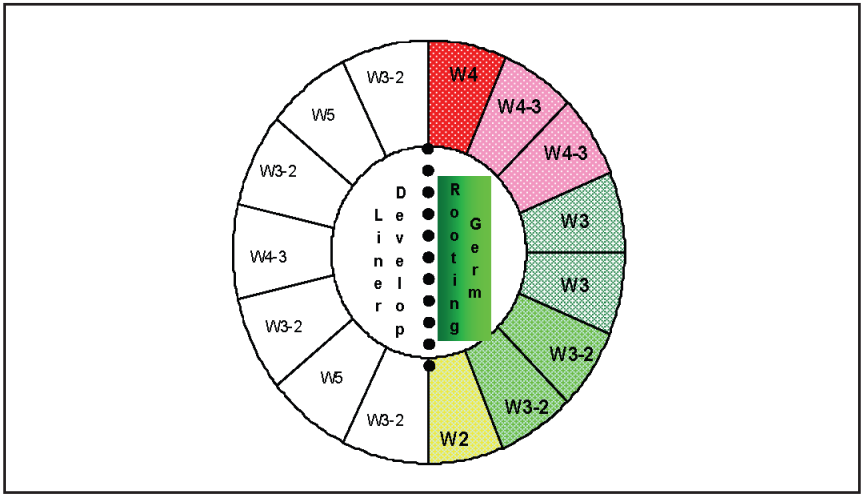

Figure 1. The right half of the production wheel shows different water levels that will optimize growth for rooting of cuttings.

for rooting of cuttings. The initial stages require constant moisture (M4). Once callus forms the soil should dry back (M3). As roots begin to form the soil moisture is further reduced to a M2 to promote rapid root development. The right side of the production wheel is the weekly pattern that the crop follows as it bulks up to a salable size.

HOW MUCH TO WATER

At each of the different stages mentioned above, not only can you tell the grower when to water but you can also determine mathematically how much water to add to reach a specific moisture level. For example, once the cutting starts to callus we water when the soil reaches an M3 level and apply 90 sec. of mist to reach M4. This is particularly important when you start root development since excess 180 sec. will move the soil moisture level from a M3 (correct) to M5 (excess)! Providing excess water (M5 vs M3) will require many days to dry back the soil during which time pathogens can become pervasive.

WHERE TO WATER

The grower's watering technique directly impacts how the water is applied to the three dimensional space that holds the water that is applied. Although some feel that technique is "art" we have shown that we can teach just about anyone to paint — they just won't all become Picassos! When growers use the wrong watering tools, walk at the incorrect pace (time), or hold the watering tools incorrectly, watering becomes inaccurate and inconsistent. The examples below show different tools and methods that will significantly modify the amount of water applied to any unit area. Choosing the correct method will insure the correct amount of water is applied for the plant's stage of development.

Mist Nozzle Shoulder Watering Pointed Up. When using a mist nozzle it is critical to point the nozzle up to insure that the mist is uniformly distributed over a large area (Fig. 2). If the nozzle is pointed down or held at the waist then the field

of water (FOW) (colored area) is too narrow and excess moisture is applied. Notice that the top of the water arch is at the shoulder or head height. This insures that the water uniformly falls down onto the tray which reduces water logging and compaction of the soil. This technique prevents flooding of the cells if watering is rapid and the amount of water applied per cell is low. This technique is used during Stage 1 and 2 to maintain optimum moisture levels for germination. The mist nozzle is not used during Stage 3 as the mist nozzle does not deliver sufficient moisture to the cells. Extended use of mist nozzles results in poor root development, frequent water application, and non-uniform soil moisture. Using this technique it is easy to uniformly apply the water over the entire surface due to the extreme feathering of the water amount along the edge of the FOW.

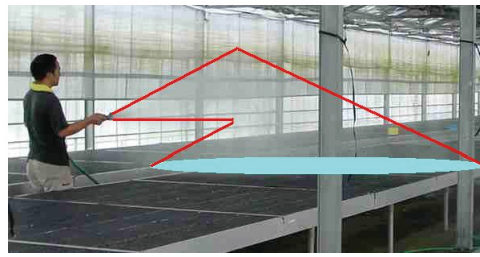

Figure 2. Mist nozzle shoulder watering pointed up.

Nozzle Waist Watering Pointed Down. When holding the nozzle at the waist and pointing down the FOW (colored area) is very narrow (2–6 cells wide) and the amount of water applied within the FOW is very high (Fig. 3). When using this technique you will flood the cells with water and can compact the soil surface. This technique is never used for Stage 1 or 2 unless trying to correct severely dry soil conditions. This technique is used to spot water and when you need to thoroughly water and area. The challenge is to uniformly apply the water over the surface as the overlap areas in the FOW can receive considerably more water than the centers of the FOW. If you do not slightly overlap then you will have dry stripes in the trays.

Figure 3. Nozzle waist watering pointed down.

Nozzle Shoulder Watering Pointed Down. When holding the nozzle at shoulder height and pointing down the FOW (colored area) is wider and the amount of water applied within the FOW is lower than using the waist watering technique (Fig. 4). When using this technique there is less flooding of the cells although there

is considerable water applied to the cells. This technique is used to spot water and fertilize the plugs during Stage 3. The challenge is to uniformly apply the water over the entire surface as the overlap areas in the FOW can receive more water than the centers of the FOW. Due to the feathering of water amount along the edge of the FOW, it is easy to uniformly apply water if the overlapped area is not too great. If you do not overlap the FOW then there will be striping in the watering pattern.

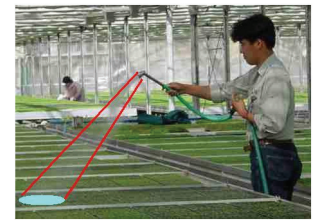

Figure 4. Nozzle shoulder watering pointed down.

Nozzle Shoulder Watering Pointed Up. When holding the nozzle at shoulder height and pointing up the FOW (colored area) is wider still and the amount of water applied within the FOW is lower than when the nozzle is pointed down (Fig. 5). Notice that the top of the water arch is at shoulder or head height. This insures that the water uniformly falls down onto the tray which reduces compaction. This technique prevents flooding of the cells if watering is rapid and the amount of water applied per cell is low. This technique is used to spot water and fertilize the plugs during Stage 3. The challenge is to uniformly apply the water over the entire surface as the overlap areas in the FOW can receive more water than the centers of the FOW. Due to the extreme feather of the water amount along the edge of the FOW, it is easy to uniformly apply water if the overlapped area is not too great. If you do not overlap the FOW then there will be striping in the watering pattern.

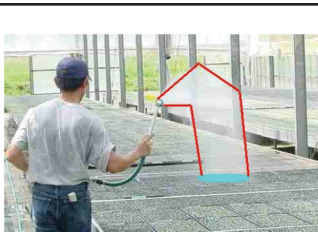

Figure 5. Nozzle shoulder watering pointed up.

WATER USAGE

Anticipating and applying the correct amount of water is where art and science intersect. We can determine the current and future drying rate based on vapor pressure deficit (VPD). Knowing the growth rate, cultural program, and anticipated VPD, you can determine when you should water (M2 or M3) and how much water should you apply (take it up 1 or 2 levels). This integration takes a considerable amount of experience or knowledge which only a few people in the organization can provide. But everyone should be able to implement the recommendation of "dry down to an M2 and add enough water to go to an M4." This is a teachable and a trainable skill.